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Resonant X-ray Scattering Study of URu2Si2

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Beamline(s): X22C

Introduction: URu2Si2 exhibits coexistence of superconductivity (*Tc*=1.4K) and antiferromagnetism (*TN*=17.5K)of uranium 5*f* electrons, which phenomena have attracted much attention for many years. Although the nature of the superconductivity is now understood as an anisotropic superconductivity from specific heat and NMR measurements,[1] the weak antiferromagnetism exhibits inconsistent results among different experimental methods and the origin remains uncovered. Neutron diffraction studies revealed an antiferromagnetic structure of 0.03μB/U moments,[2] while there exist huge macroscopic anomalies at *TN* in specific heat, resistivity and thermal expansion,[3] which indicates other "hidden parameter" as the primary order parameter. We speculate that the orbital degrees of freedom, i.e, electric quadrupole moment, of uranium 5*f* state is the hidden order parameter of this phase transition. To look for quadrupole ordering below *TN*, we have conducted resonant x-ray scattering measurements.

Methods and Materials: We have used a cylindrical shape (2.6mm$\phi \times$ 2.0mmh) single crystal of URu2Si2, which was attached to the cold finger of a conventional displex. We have tuned the incident energy at Uranium M4 and M5 edges to observe resonant x-ray scattering from quadrupole ordering at (001) and (003).

Results: Unfortunately, the incident beam around 3.7keV was heavily contaminated from λ/3. After detuning the monochromator to sufficiently get rid of the λ/3 contamination, the λ intensity also became very weak; the (002) fundamental reflection barely reached 1000cps. We have also tried to optimize the electronics, but in vain.

Conclusions: We believe that the research is worth continuing in NSLS. There are not many diffractometers in the world, which can reach this low incidnet energy region at low temperatures. Moreover, clarifying the nature of the phase transition at *TN*=17.5K of URu2Si2 has a fundamental importance in the research field of heavy fermions and 5*f* electron systems. However, it is necessary to make significant improvements upon the optics of X22C for the success. Putting an additional mirror to cut off higher energy contaminations in the hatch can be a solution.

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